ORIGINAL ARTICLE

NOISE EXPOSURE AMONG MAINTENANCE CREWS OF C130H AIRCRAFT LEAD TO THE HEARING IMPAIRMENT

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ABSTRACT

The objectives of the research are to identify the noise sources and noise level exposure inside C130H aircraft's hangar; to produce noise mapping; to identify hearing status of C130H aircraft maintenance crews (MC); and suggesting the noise control measure that can be applied. A field survey on noise level by using a digital sound level meter and producing noise mapping. A hearing testing among 63 MC was carried out in Institute of Aviation Medicine, Royal Malaysian Air Force (RMAF). Reviewing the literature and analyzing some control measures to be taken. Hearing test result shown 41.2% of the MC are having hearing impairment. The highest noise level at the central of the hangar is 92.2 dBA (day-time) and 94.2 dBA (night-time) when there is a C130H aircraft starting its engine at 50 meters from the central of the hangar, 95.3 dBA (day-time) and 97.3 dBA (night-time) when there is a C130H aircraft Engine Ground Run at 150 meters from the central of the hangar. Besides, Auxiliary Power Unit is producing the highest noise level which is 125.7 dBA (day-time) and 127.7 dBA (night-time). The application of Personal Protective Equipment (PPE) is the very likely control measure to be taken while engineering control is very costly but can be considered. Since noise is recognized as a hazard, hearing protection as PPE will not be the ultimate solution as a control measure. Hence, the Engineering Control must be identified and studied to be implemented as an ultimate solution to control the noise hazard in long term duration.

Keywords: *C130H aircraft, maintenance crew, noise exposure.*

INTRODUCTION

Aviation industry is a rated field that expose to the high decibels sound. Royal Malaysian Air Force (RMAF) is one of it as the aviation company/industry which having a lot of aircraft types in the inventory and one of it is the C130 Hercules (C130H) aircraft. The Lockheed Martin C130H aircraft is a four-engine turboprop military designed and originally built by Lockheed Martin Company.

Referring to the Sound Level Data Base and the field survey (refer Table 1), the turboprop military aircraft is producing 94 dB which is above the Permissible Exposure Limit (PEL) (allowable is 85 dB refer to the FMA (Noise Exposure) Regulation 1989 for 8 hours) and classified as a hazard (Brink LL et. al, 2002). Hence, aircraft maintenance crew working on shift for 24 hours are highly expose to the noise that created by Auxiliary Power Unit (APU), Ground Power Unit (GPU), Aircraft Towing Tractor, aircraft's engines during Engine Ground Run (EGR) and from the precaution sound during opening and closing the hangar's door. Thus, in order to prevent adverse outcomes of noise exposure, noise levels should be reduced to the acceptable levels. The best method or control measures of noise reduction should be taken by the organization and would be selected from the five elements of control measure of hazard (Administrative Control, Engineering Control, Elimination, Substitution and Personal Protective Equipment (PPE)). Hence, Risk Assessment on hangar of C130H aircraft will be carried out to identify, to analyze and to take action on the control measure of the noise hazard.

The maintenance activities are carried out neither inside the hangar nor outside the hangar which is known as dispersal area. Dispersal area is the area to park the C130H aircraft, to refuel, to start up and shut down the aircraft and to EGR the aircraft. The EGR bay also located in the dispersal area.

Indeed, this research tried to achieve these objectives: (1) to identify the noise sources and noise level exposure inside C130H aircraft's hangar; (2) to produce noise mapping; (3) to identify hearing status of C130H aircraft maintenance crews (MC); and (4) suggesting the noise control measure that can be applied. The following section would discuss on the methodology, research findings and concluded accordingly with the limitation.

MATERIALS AND METHOD

The sample of this research is among the maintenance crews who are working with C130H aircraft in No 20 Squadron, Subang Air Base. The maintenance crews involved during maintenance activities neither inside the hangar nor outside the hangar.

Field survey to identify the noise sources and noise level is carried out day and night time by using a Digital Sound Level Meter (P/No: GM 1351) which is designed by the manufacturer to meet the requirement and standard according to IEC651 TYPE 2 and ANSI S1.4 TYPE 2 (refer Table 1). The data collection of the noise level is justified as the real noise level that entering maintenance crew's ear.

Hence, the noise mapping is produced to plot the red area as an above Permissible Exposure Limit (PEL) area and green area as a lower the PEL area (refer Figure 1).

To determine the hearing status of the maintenance crews, 63 aircraft maintenance crews which are 20% from the total maintenance crews (180 crews) are sent to the Institute of Aviation Medicine, RMAF for hearing test. The maintenance crews that are sent for the hearing test are selected from three categories which are below five years served in No 20 Squadron, between six to 10 years and more than 10 years served in No 20 Squadron.

RESULTS

Among the 63 maintenance crews who are selected in this research, 33.3% are working more than 10 years in No 20 Squadron, 33.3% within five years and 33.4% between six to 10 years. 100% are exposed to the GPU sound and warning sound from hangar's door, 80% are involved in EGR, 60% are exposed from APU sound, 55.24% involve in FCF and 20% percent are exposed to the powered machine. All maintenance crews are working 24 hours shift concept, 15 days per month.

Besides, to identify the hearing status of the maintenance crews, 63 maintenance crews are sent to the Institute of Aviation Medicine RMAF for hearing test and as a result, 41.2% are having a hearing impairment. All samples are tested with 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 5000 Hz, 6000 Hz, 7000 Hz and 8000 Hz. The 41.2% of the samples are identified as having a hearing impairment after fail during audiometric testing with 4000 Hz, 5000 Hz, 6000 Hz, 7000 Hz and 8000 Hz. Based on the 41.2% of the maintenance crews having hearing impairment, 33.3% are from maintenance crews that are served in No 20 Squadron more than 10 years and another 7.9% are from maintenance crews that are served within six to 10 years in No 20 Squadron.

As a guideline and Administrative Control, noise mapping is produced to plot the red area which is above the PEL area and green area which is below PEL area (refer Figure 1).

Figure 1: Noise mapping in No 20 Squadron

Table 1: Average Noise Level of the Noise Sources

NO	SITUATION	VALUE (dBA) Day	VALUE (dBA) Night	REMARK
1.	MARSHALLING (DAY TIME)			
	-MARSHALLER/FIRE EXTINGUISHER			
	1 ENGINE			20m - **108.0dB**, 30m - **104.0dB**
	2 ENGINES			20m - **113.9dB**, 30m - **108.9dB**
	3 ENGINES			20m - **116.5dB**, 30m - **112.6dB**
	4 ENGINES			20m - **117.6dB**, 30m - **114.4dB**
	-MC ON TRACTOR			20m - **107.1dB**
1.	MARSHALLING (NIGHT TIME)			
	-MARSHALLER/FIRE EXTINGUISHER			
	1 ENGINE			20m - **110.0dB**, 30m - **106.0dB**
	2 ENGINES			20m - **115.9dB**, 30m - **110.9dB**
	3 ENGINES			20m - **118.5dB**, 30m - **114.6dB**
	4 ENGINES			20m - **119.6dB**, 30m - **116.4dB**
	-MC ON TRACTOR			20m - **109.1dB**
2.	EGR (RECTIFICATION) WITH 2 ENGINES (LOW SPEED) AT BAY 17 (NEAREST BAY) TO THE HANGAR	**97.6**	**99.6**	FS 245
		89.1	**91.1**	CENTER
		93.6	**95.6**	PARATROOP DOOR
		112.9	**114.9**	RAMP DOOR
		88.7	**90.7**	AT CENTER OF THE HANGAR
3.	EGR (RECTIFICATION) WITH 4 ENGINES (LOW SPEED) AT BAY 17 (NEAREST BAY) TO THE HANGAR	**91.3**	**93.3**	FS 245
		89.4	**91.4**	CENTER
		94.8	**96.8**	PARATROOP DOOR
		95.9	**97.9**	RAMP DOOR
		93.9	**95.9**	AT CENTER OF THE HANGAR
4.	EGR (RECTIFICATION) WITH 2 ENGINES (NORMAL SPEED) AT BAY 17 (NEAREST BAY) TO THE HANGAR	**100.1**	**102.1**	FS 245
		89.7	**91.7**	CENTER
		95.6	**97.6**	PARATROOP DOOR
		114.3	**116.3**	RAMP DOOR
		94.4	**96.4**	AT CENTER OF THE HANGAR
5.	EGR (RECTIFICATION) WITH 4 ENGINES (NORMAL SPEED) AT BAY 17 (NEAREST BAY) TO THE HANGAR	**94.0**	**96.0**	FS 245
		92.2	**94.2**	CENTER
		97.8	**99.8**	PARATROOP DOOR
		98.9	**100.9**	RAMP DOOR
		96.8	**98.8**	AT CENTER OF THE HANGAR
6.	EGR (RECTIFICATION) WITH 2 ENGINES (CROSS OVER) AT EGR BAY	**96.5**	**98.5**	FS 245
		94.3	**96.3**	CENTER
		98.9	**100.9**	PARATROOP DOOR
		100.5	**102.5**	RAMP DOOR
		90.0	**92.0**	AT CENTER OF THE HANGAR
7.	EGR (RECTIFICATION) WITH 4 ENGINES (CROSS OVER) AT EGR BAY	**98.1**	**100.1**	FS 245
		95.2	**97.2**	CENTER
		99.7	**101.7**	PARATROOP DOOR
		101.2	**103.2**	RAMP DOOR
		91.1	**93.1**	AT CENTER OF THE HANGAR
8.	EGR (RECTIFICATION) WITH 2 ENGINES (TAKE OFF POWER) AT EGR BAY	**93.9**	**95.9**	FS 245
		92.1	**94.1**	CENTER
		96.9	**98.9**	PARATROOP DOOR
		98.8	**100.8**	RAMP DOOR
		88.6	**90.6**	AT CENTER OF THE HANGAR
9.	EGR (RECTIFICATION) WITH 4 ENGINES (TAKE OFF POWER) AT EGR BAY	**94.7**	**96.7**	FS 245
		95.3	**97.3**	CENTER
		97.8	**99.8**	PARATROOP DOOR
		99.6	**101.6**	RAMP DOOR
		89.7	**91.7**	AT CENTER OF THE HANGAR
10.	RECTIFICATION WITH 4 ENGINES (IN FLIGHT)	**93.3**	**95.3**	FS 245
		90.5	**92.5**	CENTER
		90.1	**92.1**	PARATROOP DOOR
		90.3	**92.3**	RAMP DOOR
11.	OPENING AND CLOSING HANGAR'S DOOR	**88.3**	**90.3**	NOISE SOURCE
		84.5	**86.5**	10m
		82.5	84.5	20m
		81.0	83.0	30m

NO	SITUATION	VALUE (dBA) Day	VALUE (dBA) Night	REMARK
		80.1	82.1	AT CENTER OF THE HANGAR
12.	GROUND POWER UNIT (GPU)	**85.6**	**87.6**	NOISE SOURCE
		80.6	82.6	10m
		75.1	77.1	20m
		74.1	76.1	30m
13.	AUXILIARY POWER UNIT (APU)	**125.7**	**127.7**	NOISE SOURCE
		118.3	**120.3**	10m
		108.1	**110.1**	20m
		98.8	**100.8**	30m
		88.4	**90.4**	Center in cargo compartment
		95.9	**97.9**	FS 245
14.	DRIVING TOWING TRACTOR	73.0	75.0	NOISE SOURCE (STATIC)
		91.5	**93.5**	NOISE SOURCE (REVERSE TOWING)
		92.6	**94.6**	NOISE SOURCE (FWD)
		83.7	**85.7**	NOISE SOURCE (FWD TOWING)
		84.0	**86.0**	10m
		82.3	84.3	20m
		81.2	83.2	30m

The highest noise level at the central of the hangar is 92.2 dBA (day-time) and 94.2 dBA (night-time) when there is a C130H aircraft starting its engine at 50 meters from the central of the hangar. The C130H aircraft starting engine give a meaning that the aircraft starting all four engines with Low-Speed Ground Idle (LSGI) and up to High-Speed Ground Idle (HSGI) but below crossover range which below 60% maximum power. Besides, the highest noise level measured at the central of the hangar is 95.3 dBA (day-time) and 97.3 dBA (night-time) when there is a C130H aircraft Engine Ground Run (EGR) at 150 meters from the central of the hangar. The EGR means the all four engines of C130H aircraft producing 100% take-off power. The EGR was carried out at the EGR Bay for rectification which is called as unscheduled servicing activities and also for on ground performance check called as scheduled servicing activities. Above and beyond, Auxiliary Power Unit (APU) is producing the highest noise level which is 125.7 dBA (day-time) and 127.7 dBA (night-time). APU is the Aircraft Ground Support Equipment (AGSE) to produce compressed air for on ground start-up.

DISCUSSION

Despite a high awareness of noise as an occupational hazard among the maintenance crew in No 20 Squadron, Subang Air Base, the availability and use of hearing protection were poor. The only maintenance crew in Airframe, Engine, Electrical and Instrument aircraft trade, are considered to be exposed to harmful noise. However, due to the insufficient resource, only 8.57% maintenance crew is supplied with the Ear Defender.

This is a cross-sectional study which measured noise levels and managed to show a correlation between exposure to noise and awareness of noise as a health hazard. In most of the studies, neither managers nor workers are conscious of hazardous noise (Akande TM, Ologe FE., 2003) (Leinster P et al., 1994). As in this study, it is revealed that awareness of noise hazard and health effect is quite high in comparison to other studies (Mina BM, Moshi NH & Riwa P, 2003). In term of awareness, it is appeared to derive from the personal experience of working in noisy environments rather than from health education (Kahan E & Ross E, 1994). Indeed, it is supported in this study as 55.24% of our subjects are working in the squadron more than 10 years but only 8.57% had education on prevention of noise hazard.

Occupational Noise Hazard is poorly studied in No 20 Squadron. A study among aircraft maintenance crew showed that they are poorly informed on the hazards of Noise Hazard with the reluctant and arbitrary use of hearing protectors and reluctant to have personal Ear Defender although known that there is insufficient Ear Defender in the Squadron. However, a recent study among industrial workers in Tanzania showed a good awareness (80% of employees) that Noise Induced Hearing Loss (NIHL) could be prevented by appropriate ear protection (Mina BM, Moshi NH & Riwa P, 2003).

Effective legislation against noise and NIHL preventive programs are well established in industrialized countries but are lacking in most of the developing countries (World Health Organization 1997) (Akande TM, Ologe FE. 2003). Generally, measures to deal with the risk of developing NIHL are often inadequate (World Health Organization 1997; Akande TM, Ologe FE. 2003; Leinster P et al. 1994), in fact, the same condition is faced in the military. A study in No 20 Squadron found that hearing protec-

tion is not provided and make to 91.43% maintenance crew are not using it all the time while only 8.57% using personal Ear Defender. There is also continuing evidence of poor compliance with NIHL preventative measures even in developed countries (Reilly MJ, Rosenman KD & Kalinowski DJ, 1998; Palmer KT et. al, 2002). Thus, poor attitudes towards NIHL are global and may play a greater role in the universal burden of NIHL than the uncontrollable harmful noise itself. As current suggestion, the procedure on the noise hazard must be developed urgently and personal Ear Defender must be provided for better improvement for the management level. Indeed, the awareness of the noise hazard and health effect programs must be continuously carry out. This study did not investigate the reducing noise at source or management attitudes but these factors are an important part of an increasing the awareness of noise hazard and health effect and the importance of providing the personal ED. Hopefully, this study can act as a catalyst for a positive change in the Engineering Management concept and perception on the effect of the Noise Hazard to the aircraft maintenance crews.

CONCLUSION

Since noise is recognized as a hazard, hearing protection as Personal Protective Equipment (PPE) will not be the ultimate solution as a control measure. Hence, the Engineering Control must be identified and studied to be implemented in No 20 Squadron as an ultimate solution to control the noise hazard in long term duration. The noise sources cannot be eliminated, however, the noise level from the noise sources can be managed and controlled by engineering element such as by implementation of the noise barrier in the hangar. Hence, the engineering element that can be applied in No 20 Squadron can be identified and there is an opportunity to enhance the research and the study.

ABBREVIATIONS

MC-Maintenance Crews, RMAF-Royal Malaysian Air Force, PPE-Personal Protective Equipment, C130H-C130 Hercules, PEL-Permissible Exposure Limit, FMA-Factory Machinery Act, APU-Auxiliary Power Unit, GPU-Ground Power Unit, EGR-Engine Ground Run, FCF-Functional Check Flight, LSGI-Low Speed Ground Idle, HSGI-High Speed Ground Idle, NIHL-Noise Induced Hearing Loss.

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CONFLICT OF INTEREST

There is no conflict of interest.

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